

6,894,517.

**North America  
Intellectual Property Corporation**

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**FROM: Winston Hsu, PATENT AGENT, REG. NO.: 41,526**

**SERIAL NO.: 10/065,432**

**ATTORNEY DOCKET NO.: NAUP0496USA**

**SUBJECT: REQUEST FOR CERTIFICATE OF  
CORRECTION**

**TOTAL PAGES: 27 PAGES (INCLUDING COVER PAGE)**

**Winston Hsu JUL 15 2005**

NAUP0496USA0\_AS\_1

**JUL 20 2005**

PTO/SB/97 (09-04)

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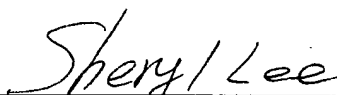
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Application Number: 10/065,432

(1) Transmittal Form	1 PAGE
(2) Fee Transmittal Form	1 PAGE
(3) Statement of request for COC	2 PAGES
(4) Attachments	21 PAGES

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**TRANSMITTAL  
FORM**

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Total Number of Pages in This Submission

25

Application Number	10/065,432
Filing Date	10/17/2002
First Named Inventor	Ting-Kuo Kang
Art Unit	2829
Examiner Name	Evan Pert
Attorney Docket Number	NAUP0496USA

**ENCLOSURES (Check all that apply)**

<input checked="" type="checkbox"/> Fee Transmittal Form <input type="checkbox"/> Fee Attached <input type="checkbox"/> Amendment/Reply <input type="checkbox"/> After Final <input type="checkbox"/> Affidavits/declaration(s) <input type="checkbox"/> Extension of Time Request <input type="checkbox"/> Express Abandonment Request <input type="checkbox"/> Information Disclosure Statement <input type="checkbox"/> Certified Copy of Priority Document(s) <input type="checkbox"/> Reply to Missing Parts/ Incomplete Application <input type="checkbox"/> Reply to Missing Parts under 37 CFR 1.52 or 1.53	<input type="checkbox"/> Drawing(s) <input type="checkbox"/> Licensing-related Papers <input type="checkbox"/> Petition <input type="checkbox"/> Petition to Convert to a Provisional Application <input type="checkbox"/> Power of Attorney, Revocation Change of Correspondence Address <input type="checkbox"/> Terminal Disclaimer <input type="checkbox"/> Request for Refund <input type="checkbox"/> CD, Number of CD(s) _____ <input type="checkbox"/> Landscape Table on CD	<input type="checkbox"/> After Allowance Communication to TC <input type="checkbox"/> Appeal Communication to Board of Appeals and Interferences <input type="checkbox"/> Appeal Communication to TC (Appeal Notice, Brief, Reply Brief) <input type="checkbox"/> Proprietary Information <input type="checkbox"/> Status Letter <input checked="" type="checkbox"/> Other Enclosure(s) (please identify below): -Statement of request for COC -A copy of the front page of the Patent -A copy of the submission of RCE filed on 11/12/2004. -A copy of the notice of allowance.
Remarks _____		

**SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT**

Firm Name	North America Intellectual Property Corporation		
Signature	<i>Winston Hsu</i>		
Printed name	Winston Hsu		
Date	JUL 15 2005	Reg. No.	41,526

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Effective on 12/08/2004.

Fees pursuant to the Consolidated Appropriations Act, 2005 (H.R. 4818).

**FEE TRANSMITTAL**  
**For FY 2005**☐ Applicant claims small entity status. See 37 CFR 1.27**TOTAL AMOUNT OF PAYMENT** (\$) 0.00**Complete If Known**

Application Number	10/065,432
Filing Date	10/17/2002
First Named Inventor	Ting-Kuo Kang
Examiner Name	Evan Pert
Art Unit	2829
Attorney Docket No.	NAUP0496USA

**METHOD OF PAYMENT (check all that apply)**

☐ Check ☐ Credit Card ☐ Money Order ☐ None ☐ Other (please identify): \_\_\_\_\_

☒ Deposit Account Deposit Account Number: 50-3105 Deposit Account Name: North America Intellectual Property Corp.

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**FEE CALCULATION****1. BASIC FILING, SEARCH, AND EXAMINATION FEES**

Application Type	FILING FEES		SEARCH FEES		EXAMINATION FEES		Fees Paid (\$)
	Fee (\$)	Small Entity Fee (\$)	Fee (\$)	Small Entity Fee (\$)	Fee (\$)	Small Entity Fee (\$)	
Utility	300	150	500	250	200	100	
Design	200	100	100	50	130	65	
Plant	200	100	300	150	160	80	
Reissue	300	150	500	250	600	300	
Provisional	200	100	0	0	0	0	

**2. EXCESS CLAIM FEES**

Fee Description	Fee (\$)	Small Entity Fee (\$)
Each claim over 20 or, for Reissues, each claim over 20 and more than in the original patent	50	25
Each independent claim over 3 or, for Reissues, each independent claim more than in the original patent	200	100
Multiple dependent claims	360	180

Total Claims	Extra Claims	Fee (\$)	Fee Paid (\$)	Multiple Dependent Claims	Fee (\$)	Fee Paid (\$)
- 20 or HP =	x	=				
HP = highest number of total claims paid for, if greater than 20						
Indep. Claims	Extra Claims	Fee (\$)	Fee Paid (\$)			
- 3 or HP =	x	=				
HP = highest number of independent claims paid for, if greater than 3						

**3. APPLICATION SIZE FEE**

If the specification and drawings exceed 100 sheets of paper, the application size fee due is \$250 (\$125 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).

Total Sheets	Extra Sheets	Number of each additional 50 or fraction thereof	Fee (\$)	Fee Paid (\$)
- 100 =	/ 50 =	(round up to a whole number) x	=	

**4. OTHER FEE(S)**

Non-English Specification, \$130 fee (no small entity discount)

Other: \_\_\_\_\_

**Fees Paid (\$)****SUBMITTED BY**

Signature	<i>Winston Hsu</i>	Registration No. (Attorney/Agent)	41,526	Telephone	302-729-1562
Name (Print/Type)	Winston Hsu	Date	JUL 15 2005		

This collection of information is required by 37 CFR 1.136. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 30 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

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JUL 20 2005

**PATENT**

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

Patent No.: 6,894,517 Issue Date: 05/17/2005  
5 App. No.: 10/065,432 Filing Date: 10/17/2002  
Inventors : Ting-Kuo Kang et al.  
Examiner: Evan Pert Art Unit: 2829  
Docket No.: NAUP0496USA

10 Title: METHOD OF MANUFACTURING A SEMICONDUCTOR DEVICE  
HAVING AN OXIDE LAYER

To: Commissioner for Patents  
P.O. BOX 1450  
15 Alexandria, VA 22313-1450

Subject: Request for Certificate of Correction under 37 CFR 1.322

Dear Sir,

20

Upon reviewing the above-identified patent, patentee noted the title of the invention should be corrected. Applicant has requested to amend the invention title when submitting RCE of the above-identified patent on November 12, 2004. And the notice of allowance also indicates that the title was amended. According to both  
25 of the reasons this mistake should be considered as an Office mistake of consequence. As the agent of record, I hereby request that a Certificate of Correction be issued under 37 CFR 1.322 to correct invention title from "Method for Monitoring Oxide Quality" to "Method Of Manufacturing A Semiconductor Device Having An Oxide Layer".

30

Attachments

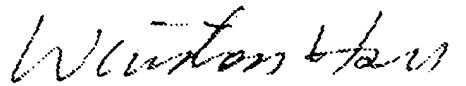
\* A copy of the front page of the Patent

\* A copy of the submission of RCE filed on 11/12/2004.

\* A copy of the notice of allowance.

Respectfully submitted,

5



Date: JUL 15 2005

Winston Hsu, Patent Agent No. 41,526

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10 Facsimile: 806-498-6673

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15



US006894517B2

(12) **United States Patent**  
Kang et al.

(10) Patent No.: **US 6,894,517 B2**  
(45) Date of Patent: **May 17, 2005**

(54) **METHOD FOR MONITORING OXIDE QUALITY**

(75) Inventors: **Ting-Kuo Kang**, Kao-Hsiung Hsien (TW); Yi-Fan Chen, Tai-Chung (TW); Chia-Jen Kao, Hsin-Chu (TW)

(73) Assignee: **United Microelectronics Corp.**, Hsin-Chu (TW)

(\*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 135 days.

(21) Appl. No.: **10/065,432**

(22) Filed: **Oct. 17, 2002**

(65) **Prior Publication Data**

US 2004/0077110 A1 Apr. 22, 2004

(51) Int. Cl.<sup>7</sup> ..... **G01R 31/02**

(52) U.S. Cl. .... **324/765; 324/766**

(58) Field of Search ..... **438/5-18; 324/765, 324/557, 558, 71.1, 71.5, 766**

(56) **References Cited**

**U.S. PATENT DOCUMENTS**

6,583,641 B2 \* 6/2003 Wang et al. .... 324/765

\* cited by examiner

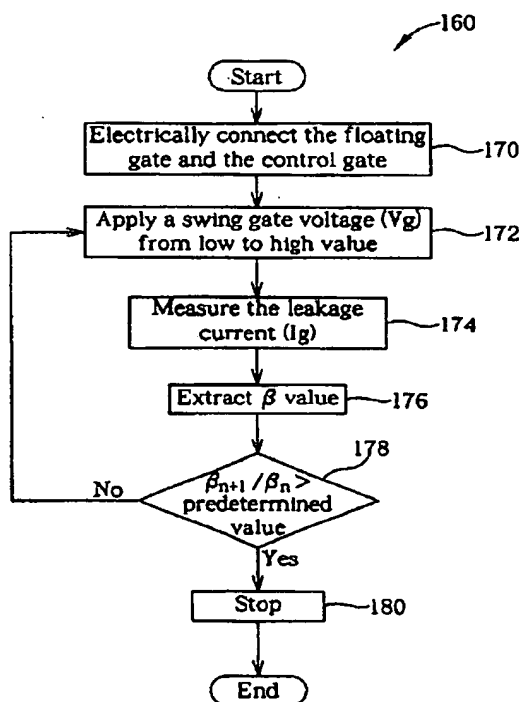
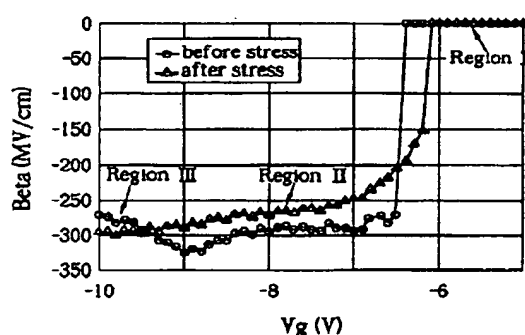
*Primary Examiner*—Evan Pert

(74) *Attorney, Agent, or Firm*—Winston Hsu

(57) **ABSTRACT**

The present invention utilizes to wafer acceptance testing equipment to fast monitor the quality of a tunnel oxide layer. First, a control gate and a floating gate in a memory cell are electrically connected. Then a plurality of swing time-dependent DC ramping voltages are applied and each corresponding gate leakage current is measured to calculate each corresponding  $\beta$  value. Finally a ratio of each  $\beta$  value is calculated and a  $\beta$ -gate voltage curve is plotted to actually simulate the device failure.

**43 Claims, 7 Drawing Sheets**



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T-192 P01/17 U-330

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**Voice Mail: 302-729-1562 FAX:806-498-6673 e-mail:winstonhsu@naipo.com**

**FAX TO : Pert, Evan T**

**ART UNIT: 2829**

**Tel : (571) 272-2800**

**Fax: (703) 872-9306**

**FROM : Winston Hsu, PATENT AGENT, REG. NO. : 41,526**

**SUBJECT: SERIAL NO. : 10/065,432**

**REQUEST FOR CONTINUED EXAMINATION (RCE)**

**TOTAL PAGES : 17 PAGES (INCLUDING COVER PAGE)**

**Winston Hsu 2004/11/12**



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T-192 P02/17 U-330

PTO/SB/30 (09-04)

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**Request  
for  
Continued Examination (RCE)  
Transmittal**Address to:  
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P.O. Box 1450  
Alexandria, VA 22313-1450

Application Number	10/085,432
Filing Date	10/17/2002
First Named Inventor	Ting-Kuo Kang
Art Unit	2829
Examiner Name	Peri, Evan T
Attorney Docket Number	NAUP0496USA

This is a Request for Continued Examination (RCE) under 37 CFR 1.114 of the above-identified application. Request for Continued Examination (RCE) practice under 37 CFR 1.114 does not apply to any utility or plant application filed prior to June 8, 1995, or to any design application. See Instruction Sheet for RCEs (not to be submitted to the USPTO) on page 2.

1. **Submission required under 37 CFR 1.114** Note: If the RCE is proper, any previously filed unentered amendments and amendments enclosed with the RCE will be entered in the order in which they were filed unless applicant instructs otherwise. If applicant does not wish to have any previously filed unentered amendment(s) entered, applicant must request non-entry of such amendment(s).

- a. ☐ Previously submitted. If a final Office action is outstanding, any amendments filed after the final Office action may be considered as a submission even if this box is not checked.
- i. ☐ Consider the arguments in the Appeal Brief or Reply Brief previously filed on \_\_\_\_\_
- ii. ☐ Other \_\_\_\_\_
- b. ☒ Enclosed
- i. ☒ Amendment/Reply
- ii. ☐ Affidavit(s)/Declaration(s)
- iii. ☐ Information Disclosure Statement (IDS)
- iv. ☐ Other \_\_\_\_\_

**2. Miscellaneous**

- a. ☐ Suspension of action on the above-identified application is requested under 37 CFR 1.103(c) for a period of \_\_\_\_\_ months. (Period of suspension shall not exceed 3 months; Fee under 37 CFR 1.17(f) required)
- b. ☐ Other \_\_\_\_\_

**3. Fees**

The RCE fee under 37 CFR 1.17(e) is required by 37 CFR 1.114 when the RCE is filed.

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- a. ☒ Deposit Account No. 503105. I have enclosed a duplicate copy of this sheet.
- i. ☒ RCE fee required under 37 CFR 1.17(e)
- ii. ☐ Extension of time fee (37 CFR 1.136 and 1.17)
- iii. ☐ Other \_\_\_\_\_
- b. ☐ Check in the amount of \$ \_\_\_\_\_ enclosed
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Signature	<i>Winston Hsu</i>	Date	11/12/2004
Name (Print/Type)	Winston Hsu	Registration No.	41,526

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## FEE TRANSMITTAL for FY 2005

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☐ Applicant claims small entity status. See 37 CFR 1.27

<b>TOTAL AMOUNT OF PAYMENT</b>	(\$ 790.00)	<b>Complete if Known</b>
		Application Number 10/065,432
		Filing Date 10/17/2002
		First Named Inventor Ting-Kuo Kang
		Examiner Name Pert, Evan T
		Art Unit 2828
		Attorney Docket No. NAUP0496USA

<b>METHOD OF PAYMENT (check all that apply)</b> <input type="checkbox"/> Check <input type="checkbox"/> Credit card <input type="checkbox"/> Money Order <input type="checkbox"/> Other <input type="checkbox"/> None <input checked="" type="checkbox"/> Deposit Account: Deposit Account Number 50-3105 Deposit Account Name North America Intellectual Property Corp. The Director is authorized to: (check all that apply) <input checked="" type="checkbox"/> Charge fee(s) indicated below <input checked="" type="checkbox"/> Credit any overpayments <input checked="" type="checkbox"/> Charge any additional fee(s) or any underpayment of fee(s) <input type="checkbox"/> Charge fee(s) indicated below, except for the filing fee to the above-identified deposit account.	<b>FEE CALCULATION (continued)</b> <b>3. ADDITIONAL FEES</b> Large Entity Small Entity Fee Code Fee Code Fee Description Fee Paid 1051 130 2051 65 Surcharge - late filing fee or cash 1052 60 2052 25 Surcharge - late provisional filing fee or cover sheet 1053 130 1053 130 Non-English specification 1812 2,520 1812 2,520 For filing a request for ex parte reexamination 1804 920 1804 920 Requesting publication of SIR prior to Examiner action 1805 1,840 1805 1,840 Requesting publication of SIR after Examiner action 1251 110 2251 65 Extension for reply within first month 1252 430 2252 215 Extension for reply within second month 1253 980 2253 490 Extension for reply within third month 1254 1,530 2254 765 Extension for reply within fourth month 1255 2,080 2255 1,040 Extension for reply within fifth month 1401 340 2401 170 Notice of Appeal 1402 340 2402 170 Filing a brief in support of an appeal 1403 300 2403 150 Request for oral hearing 1451 1,510 1451 1,510 Petition to institute a public use proceeding 1452 110 2452 55 Petition to revive - unavoidable 1453 1,330 2453 665 Petition to revive - unintentional 1501 1,370 2501 685 Utility issue fee (or reissue) 1502 490 2502 245 Design issue fee 1503 660 2503 330 Plant issue fee 1460 130 1460 130 Petitions to the Commissioner 1807 50 1807 50 Processing fee under 37 CFR 1.17(g) 1808 180 1806 180 Submission of Information Disclosure Stmt 8021 40 8021 40 Recording each patent assignment per property (times number of properties) 1809 790 2809 395 Filing a submission after final rejection (37 CFR 1.129(e)) 1810 790 2810 395 For each additional invention to be examined (37 CFR 1.128(b)) 1801 790 2801 395 Request for Continued Examination (RCE) 1802 900 1802 900 Request for expedited examination of a design application Other fee (specify) _____ *Reduced by Basic Filing Fee Paid <b>SUBTOTAL (3) (\$ 790.00)</b>
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<b>1. BASIC FILING FEE</b> Large Entity Small Entity Fee Code Fee Code Fee Description Fee Paid 1001 790 2001 395 Utility filing fee 1002 350 2002 175 Design filing fee 1003 550 2003 275 Plant filing fee 1004 790 2004 395 Reissue filing fee 1005 180 2005 80 Provisional filing fee <b>SUBTOTAL (1) (\$ 0.00)</b>	<b>2. EXTRA CLAIM FEES FOR UTILITY AND REISSUE</b> Total Claims -20** = _____ X _____ = _____ Independent Claims -3** = _____ X _____ = _____ Multiple Dependent _____ = _____ <b>Large Entity Small Entity</b> Fee Code Fee Code Fee Description Fee Paid 1202 18 2202 9 Claims in excess of 20 1201 88 2201 44 Independent claims in excess of 3 1203 300 2203 150 Multiple dependent claim, if not paid 1204 88 2204 44 ** Reissue independent claims over original patent 1205 18 2205 9 ** Reissue claims in excess of 20 and over original patent <b>SUBTOTAL (2) (\$ 0.00)</b>
--	--

\*or number previously paid, if greater; For Reissues, see above

<b>SUBMITTED BY</b>		<b>(Complete if applicable)</b>	
Name (Print/Type) Winston Hsu	Registration No. 41,526	Telephone 302-729-1582	
Signature <i>Winston Hsu</i>		Date 11/12/2004	

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T-192 P04/17 U-330

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Date

*Shelley Kuo*

Signature

Shelley Kuo

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Registration Number, if applicable

Telephone Number

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APPLICATION NUMBER: 10/065,432

PAPERS INCLUDED:

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(2) Fee Transmittal	1 PAGE
(3) Request for Continued Examination	13 PAGES

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T-192 P05/17 U-330

## METHOD FOR MONITORING OXIDE QUALITY

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Appl. No. : 10/065,432 Confirmation  
No.6760

Applicant : Ting-Kuo Kang,  
Yi-Fan Chen,  
Chia-Jen Kao

Filed : October 17, 2002

TC/A.U. : 2829

Examiner : Pert, Evan T

Docket No. : NAUP0496USA

Customer : 027765

No.

Commissioner for Patents  
P.O. Box 1450  
Alexandria VA 22313-1450

**AMENDMENT**

Sir:

- 5 In response to the notice of allowance mailed 08/30/2004, a request for continued examination is submitted and amendments to the above-identified application are as follows:

Amendments to the Specification begin on page 2 of this paper.

- Amendments to the Claims are reflected in the listing of claims which  
10 begins on page 3 of this paper.

Remarks/Arguments begin on page 12 of this paper.

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T-192 P06/17 U-330

Appl. No. 10/065,432  
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**Amendments to the Specification:**

Please replace the title "METHOD FOR MONITORING OXIDE  
QUALITY" with the following new title:

--METHOD OF MANUFACTURING A SEMICONDUCTOR DEVICE  
5 HAVING AN OXIDE LAYER--

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T-192 P07/17 U-330

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**Amendments to the Claims:**

This listing of claims will replace all prior versions, and listings, of claims in the application.

**Listing of Claims:**

5 Claim 1 (currently amended): A method of manufacturing a semiconductor device having a tunnel oxide layer ~~for monitoring a tunnel oxide layer~~, the method comprising:

- (a) providing a semiconductor substrate and forming at least one memory cell on a surface of the semiconductor substrate, the memory  
10 cell comprising a first gate, a second gate, and the tunnel oxide layer from top to bottom in a stack;
- (b) electrically connecting the first gate and the second gate;
- (c) applying a first gate voltage to the first gate, the first gate voltage being a swing time-dependent DC ramping voltage;
- 15 (d) measuring a first gate leakage current of the memory cell to calculate a first constant from an equation;
- (e) applying a second gate voltage to the first gate, the second gate voltage being a swing time-dependent DC ramping voltage;
- 20 (f) measuring a second gate leakage current of the memory cell to calculate a second constant from the equation;
- (g) calculating a first ratio of the second constant to the first constant; and
- (h) performing a comparing step to compare the value of the first ratio with a predetermined value.

25

Claim 2 (previously presented): The method of claim 1 wherein the semiconductor substrate is a silicon substrate of a semiconductor wafer and the memory cell is formed in a testing area of the semiconductor wafer.

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Claim 3 (original): The method of claim 1 wherein the memory cell is a flash memory cell, the first gate and the second gate are a controlling gate and a floating gate of the flash memory cell respectively.

5

Claim 4 (original): The method of claim 1 wherein the memory cell is a non-volatile memory cell, the first gate and the second gate are a controlling gate and a floating gate of the non-volatile memory cell respectively.

10

Claim 5 (original): The method of claim 1 wherein the quality of the tunnel oxide layer is degenerated to be not acceptable when the value of the first ratio is greater than the predetermined value.

15 Claim 6 (previously presented): The method of claim 1 wherein the equation is the Fowler-Nordheim tunneling mechanism equation.

Claim 7 (original): The method of claim 1 wherein the predetermined value is 10.

20

Claim 8 (original): The method of claim 1 wherein each constant is a . value corresponding to each gate voltage respectively.

25 Claim 9 (previously presented): The method of claim 8 wherein the first constant is a . 1 value corresponding to the first gate voltage and the . 1 value is equal to  $\left[ \frac{\Delta \ln(|\text{the first gate leakage current}|)}{(|\text{the first gate voltage}| - |\text{a flatband voltage}(V_{fb})|)^2} \right] + \left\{ \Delta \left[ 1 \div (|\text{the first gate voltage}| - |\text{the flatband voltage}|) \right] \right\}$ .

30 Claim 10 (currently amended): The method of claim 8 wherein the second constant is a . 2 value corresponding to the second gate voltage

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and the . 2 value is equal to  $\left[ \frac{\Delta \ln[| \text{the second gate leakage current} | / (| \text{the second gate voltage} | - | \text{the flatband voltage}(V_{fb}) |)]^2}{\Delta [1 + (| \text{the second gate voltage} | - | \text{the flatband voltage} |)]} \right]$ .

5 Claim 11 (currently amended): The method of claim 8 further comprising the following steps when the value of the first ratio is not greater than the predetermined value:

applying a third gate voltage to the first gate, the third gate voltage [[is]] being a swing time-dependent DC ramping voltage;

10 measuring a third gate leakage current of the memory cell to calculate a third constant from the equation;

calculating a second ratio of the third constant to the second constant; and

performing the comparing step to compare the value of the second ratio with the predetermined value.

Claim 12 (original): The method of claim 11 wherein the steps (c) to (h) are repeated when the value of the second ratio is not greater than the predetermined value.

Claim 13 (original): The method of claim 11 wherein the quality of the tunnel oxide layer is degenerated to be not acceptable when the value of the second ratio is greater than the predetermined value.

25 Claim 14 (previously presented): The method of claim 11 wherein the third constant is a . 3 value corresponding to the third gate voltage and the . 3 value is equal to  $\left[ \frac{\Delta \ln[| \text{the third gate leakage current} | / (| \text{the third gate voltage} | - | \text{a flatband voltage}(V_{fb}) |)]^2}{\Delta [1 + (| \text{the third gate voltage} | - | \text{the flatband voltage} |)]} \right]$ .

Claim 15 (currently amended): The method of claim 14 further



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comprising ~~a step for~~ plotting a  $-V_g$  curve of each  $I$  value respectively corresponding to the first gate voltage, the second gate voltage and the third gate voltage versus the first gate voltage, the second gate voltage and the third gate voltage, and comparing a reference  $-V_g$  curve for the unstress-induced tunnel oxide layer in the memory cell ~~is compared~~ with the  $-V_g$  curve to monitor the quality of the tunnel oxide layer.

Claim 16 (original): The method of claim 15 wherein the  $-V_g$  curve comprises at least a first region (region I), a second region (region II), and a third region (region III).

Claim 17 (currently amended): The method of claim 16 wherein the  $I$  value within the first region is zero to represent each gate leakage current flowing through the first gate and the second gate in the memory cell being less than a predetermined current value, the absolute value of the  $I$  value within the second region increases to represent the stress-induced leakage current (SILC) resulting in the increase of each gate leakage current of the memory cell, and the  $I$  value within the third region crosses the reference  $-V_g$  curve to represent a plurality of carriers being trapped by the tunnel oxide layer.

Claim 18 (original): The method of claim 17 wherein the predetermined current value is  $1.0 \times 10^{-11}$  A.

Claim 19 (currently amended): The method of claim 8, further comprising ~~a step for~~ plotting a  $-V_g$  curve of each  $I$  value versus each gate voltage, and comparing a reference  $-V_g$  curve for the unstress-induced tunnel oxide layer in the memory cell ~~is compared~~ with the  $-V_g$  curve to monitor the quality of the tunnel oxide layer.

30

Claim 20 (original): The method of claim 1 wherein the method is applied to a wafer acceptance testing (WAT) equipment to fast monitor

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the stress-induced degradation of the tunnel oxide layer in the memory cell.

5 Claim 21 (currently amended) A method of manufacturing a semiconductor device having an oxide layer ~~for fast monitoring the stress-induced degradation of an oxide layer by a wafer acceptance testing (WAT) equipment~~, the method comprising:

(a) providing a substrate, a surface of the substrate comprising the oxide layer and a first conductive layer disposed on the oxide layer;

10 (b) applying a first voltage to the first conductive layer, the first voltage being a swing time-dependent DC ramping voltage;

(c) measuring a first leakage current flowing through the first conductive layer to calculate a first proportional value from the first voltage, the first leakage current, and an equation, the first  
15 proportional value corresponding to the first voltage;

(d) applying a second voltage to the first conductive layer, the second voltage being a swing time-dependent DC ramping voltage;

(e) measuring a second leakage current flowing through the first conductive layer to calculate a second proportional value from the  
20 second voltage, the second leakage current, and the equation, the second proportional value corresponding to the second voltage; and

(f) calculating a first ratio of the second proportional value to the first proportional value.

25 Claim 22 (previously presented): The method of claim 21 wherein the substrate is a silicon substrate of a semiconductor wafer and the first conductive layer is formed in a testing area of the semiconductor wafer.

Claim 23 (previously presented): The method of claim 21 wherein a  
30 second conductive layer is formed between the first conductive layer and the oxide layer.

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Claim 24 (previously presented): The method of claim 23 further comprising an electrically connecting step performed before applying the first voltage to the first conductive layer to electrically connect the first conductive layer and the second conductive layer.

5

Claim 25 (previously presented): The method of claim 24 wherein the first conductive layer and the second conductive layer are a controlling gate and a floating gate of a flash memory cell respectively, and the oxide layer is a tunnel oxide layer of the flash memory cell.

10

Claim 26 (currently amended): The method of claim 24 wherein the first conductive layer is a controlling gate of a non-volatile memory cell, the second conductive layer is a floating gate of the non-volatile memory cell, and the oxide layer is a tunnel oxide layer of the non-volatile memory cell.

15

Claim 27 (previously presented): The method of claim 21 wherein the first conductive layer is a gate of a metal-oxide-semiconductor (MOS) transistor, the oxide layer is a gate oxide layer of the MOS transistor.

20

Claim 28 (previously presented): The method of claim 21 further comprising a comparing step to compare the value of the first ratio with a predetermined value.

25

Claim 29 (previously presented): The method of claim 28 wherein the quality of the oxide layer is degenerated to be not acceptable when the value of the first ratio is greater than the predetermined value.

30

Claim 30 (original): The method of claim 28 wherein the predetermined value is 10.

Claim 31 (previously presented): The method of claim 21 wherein the

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equation is the Fowler-Nordheim tunneling mechanism equation.

Claim 32 (previously presented): The method of claim 28 wherein each proportional value is a . value corresponding to each voltage  
5 respectively.

Claim 33 (previously presented): The method of claim 32 wherein the first proportional value is a . 1 value corresponding to the first voltage and the . 1 value is equal to  $\left[ \frac{\Delta \ln \left( \frac{\text{the first leakage current}}{\left( \left| \text{the first voltage} \right| - \left| \text{a flatband voltage}(V_{fb}) \right| \right)^2} \right)}{\Delta \left[ 1 + \left( \left| \text{the first voltage} \right| - \left| \text{the flatband voltage} \right| \right) \right]} \right]$ .  
10

Claim 34 (currently amended): The method of claim 32 wherein the second proportional value is a . 2 value corresponding to the second voltage and the . 2 value is equal to  $\left[ \frac{\Delta \ln \left( \frac{\text{the second leakage current}}{\left( \left| \text{the second voltage} \right| - \left| \text{the flatband voltage}(V_{fb}) \right| \right)^2} \right)}{\Delta \left[ 1 + \left( \left| \text{the second voltage} \right| - \left| \text{the flatband voltage} \right| \right) \right]} \right]$ .  
15

Claim 35 (currently amended): The method of claim 32 further comprising the following steps when the value of the first ratio is not greater than the predetermined value:  
20

applying a third voltage to the first conductive layer, the third voltage being a swing time-dependent DC ramping voltage;

measuring a third leakage current flowing through the first  
25 conductive layer;

calculating a third proportional value from the third voltage, the third leakage current, and the equation, the third proportional value corresponding to the third voltage;

calculating a second ratio of the third proportional value to the  
30 second proportional value; and

performing the comparing step to compare the value of the second

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 ratio with the predetermined value.

Claim 36 (original): The method of claim 35 wherein the steps (b) to (f)  
 are repeated when the value of the second ratio is not greater than the  
 5 predetermined value.

Claim 37 (original): The method of claim 35 wherein the quality of the  
 oxide layer is degenerated to be not acceptable when the value of the  
 second ratio is greater than the predetermined value.

10

Claim 38 (previously presented): The method of claim 35 wherein the  
 third proportional value is a .3 value corresponding to the third voltage  
 and the .3 value is equal to  $\left[ \frac{\Delta \ln[| \text{the third leakage current} | / (| \text{the third voltage} | - | \text{a flatband voltage}(V_{fb}) | )^2]}{\Delta [1 + (| \text{the third voltage} | - | \text{the flatband voltage} |)]} \right]$ .  
 15

Claim 39 (currently amended): The method of claim 38 further  
 comprising ~~a step for plotting a .-V curve of each . value respectively~~  
 corresponding to the first voltage, the second voltage and the third  
 20 voltage versus the first voltage, the second voltage and the third  
 voltage, and comparing a reference .-V curve for the unstress-induced  
 oxide layer ~~is compared with the .-V curve~~ to monitor the quality of  
 the oxide layer.

25 Claim 40 (previously presented): The method of claim 39 wherein the  
 .-V curve comprises at least a first region (region I), a second region  
 (region II), and a third region (region III).

Claim 41 (currently amended): The method of claim 40 wherein the .  
 30 value within the first region is zero to represent each leakage current  
 flowing through the first conductive layer being less than a  
 predetermined current value, the absolute value of the . value within

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the second region increases to represent the stress-induced leakage current (SILC) resulting in the increase of each leakage current flowing through the first conductive layer, and the . value within the third region crosses the reference .-V curve to represent a plurality of  
5 carriers being trapped by the oxide layer.

Claim 42 (original): The method of claim 41 wherein the predetermined current value is  $1.0 \times 10^{-11}$  A.

10 Claim 43 (currently amended): The method of claim 32 further comprising ~~a step for~~ plotting a .-V curve of each . value versus each voltage, and comparing a reference .-V curve for the unstress-induced oxide layer ~~is compared~~ with the .-V curve to monitor the quality of the oxide layer.

15

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Amdt. dated November 12, 2004  
Request for Continued Examination

### REMARKS/ARGUMENTS

#### 1. Request for continued examination:

5

The Applicant respectfully requests continued examination of the above-indicated application as per 37 CFR §1.114.

#### 2. Amendments to the specification:

10

The title of the present application is amended to correspond with the amendments to the claims so as to be clearly indicative of the invention to which the claims are directed. No new matter is introduced by the amendments in the specification. Allowance of the amended specification is respectfully requested.

#### 3. Amendments to the claims:

In claims 1 and 21, the preambles thereof are amended to emphasize the outstanding feature of the present invention is to introduce the steps for monitoring the quality of an oxide layer into the method of manufacturing a semiconductor device having the oxide layer. These amendments are entirely supported by the disclosure. For example, paragraph [0004] recites that the semiconductor devices include MOS transistors, non-volatile memory and flash memory. Paragraph [0021] recites that the present invention examines the oxide layer quality with an in-line monitor. Paragraph [0033] recites the steps for forming the semiconductor devices in both a testing area and a normal product area. In addition, paragraphs [0034] and [0048] further recite that the steps of providing swing time-dependent DC ramping voltages and measuring leakage currents are performed in a production line. It is obvious that the steps for monitoring the oxide layer quality

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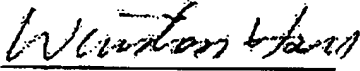
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Amdt. dated November 12, 2004  
Request for Continued Examination

can be introduced into the method of manufacturing the semiconductor devices according to the present application. Consideration of the amended claims 1 and 21 is respectfully requested.

5 Claims 10, 11, 15, 17, 19, 26, 34, 35, 39, 41, and 43 are amended to correct minor grammatical informalities identified in the claims. No new matter is introduced. Allowance of the amended claims is respectfully requested.

10 As claims 2-20 and 22-43 are dependent upon the amended claims 1 and 21, they should be allowed if the amended claims 1 and 21 are allowed. Consideration of claims 2-20 and 22-43 is therefore requested.

15 Respectfully submitted,

Date: 2004/11/12

20 Winston Hsu, Patent Agent No. 41,526

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EXAMINER

PERT, EVAN T

ART UNIT

PAPER NUMBER

2829

DATE MAILED: 12/20/2004

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/065,432	10/17/2002	Ting-Kuo Kang	NAUP0496USA	6760

TITLE OF INVENTION: METHOD OF MANUFACTURING A SEMICONDUCTOR DEVICE HAVING AN OXIDE LAYER

APPLN. TYPE	SMALL ENTITY	ISSUE FEE	PUBLICATION FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	NO	\$1400	\$300	\$1700	03/21/2005

THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. **PROSECUTION ON THE MERITS IS CLOSED.** THIS NOTICE OF ALLOWANCE IS NOT A GRANT OF PATENT RIGHTS. THIS APPLICATION IS SUBJECT TO WITHDRAWAL FROM ISSUE AT THE INITIATIVE OF THE OFFICE OR UPON PETITION BY THE APPLICANT. SEE 37 CFR 1.313 AND MPEP 1308.

THE ISSUE FEE AND PUBLICATION FEE (IF REQUIRED) MUST BE PAID WITHIN **THREE MONTHS** FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. **THIS STATUTORY PERIOD CANNOT BE EXTENDED.** SEE 35 U.S.C. 151. THE ISSUE FEE DUE INDICATED ABOVE REFLECTS A CREDIT FOR ANY PREVIOUSLY PAID ISSUE FEE APPLIED IN THIS APPLICATION. THE PTOL-85B (OR AN EQUIVALENT) MUST BE RETURNED WITHIN THIS PERIOD EVEN IF NO FEE IS DUE OR THE APPLICATION WILL BE REGARDED AS ABANDONED.

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II. PART B - FEE(S) TRANSMITTAL should be completed and returned to the United States Patent and Trademark Office (USPTO) with your ISSUE FEE and PUBLICATION FEE (if required). Even if the fee(s) have already been paid, Part B - Fee(s) Transmittal should be completed and returned. If you are charging the fee(s) to your deposit account, section "4b" of Part B - Fee(s) Transmittal should be completed and an extra copy of the form should be submitted.

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(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/065,432	10/17/2002	Ting-Kuo Kang	NAUP0496USA	6760

TITLE OF INVENTION: METHOD OF MANUFACTURING A SEMICONDUCTOR DEVICE HAVING AN OXIDE LAYER

APPLN. TYPE	SMALL ENTITY	ISSUE FEE	PUBLICATION FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	NO	\$1400	\$300	\$1700	03/21/2005

EXAMINER	ART UNIT	CLASS-SUBCLASS
PERT, EVAN T	2829	438-018000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).

- ☐ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.
- ☐ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47, Rev 03-02 or more recent) attached. Use of a Customer Number is required.

2. For printing on the patent front page, list

- (1) the names of up to 3 registered patent attorneys or agents OR, alternatively, \_\_\_\_\_ 1
- (2) the name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed. \_\_\_\_\_ 2
- \_\_\_\_\_ 3

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document has been filed for recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE

(B) RESIDENCE: (CITY and STATE OR COUNTRY)

Please check the appropriate assignee category or categories (will not be printed on the patent): ☐ Individual ☐ Corporation or other private group entity ☐ Government

4a. The following fee(s) are enclosed:

- ☐ Issue Fee
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4b. Payment of Fee(s):

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- ☐ The Director is hereby authorized by charge the required fee(s), or credit any overpayment, to Deposit Account Number \_\_\_\_\_ (enclose an extra copy of this form).

5. Change In Entity Status (from status indicated above)

- ☐ a. Applicant claims SMALL ENTITY status. See 37 CFR 1.27. ☐ b. Applicant is no longer claiming SMALL ENTITY status. See 37 CFR 1.27(g)(2).

The Director of the USPTO is requested to apply the Issue Fee and Publication Fee (if any) or to re-apply any previously paid issue fee to the application identified above.

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**Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)**  
(application filed on or after May 29, 2000)

The Patent Term Adjustment to date is 135 day(s). If the issue fee is paid on the date that is three months after the mailing date of this notice and the patent issues on the Tuesday before the date that is 28 weeks (six and a half months) after the mailing date of this notice, the Patent Term Adjustment will be 135 day(s).

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date that determines Patent Term Adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Application Information Retrieval (PAIR) WEB site (<http://pair.uspto.gov>).

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (703) 305-1383. Questions relating to issue and publication fee payments should be directed to the Customer Service Center of the Office of Patent Publication at (703) 305-8283.